Computer Modeling of Pressures on 120mm Tank Round in the M256 Gun

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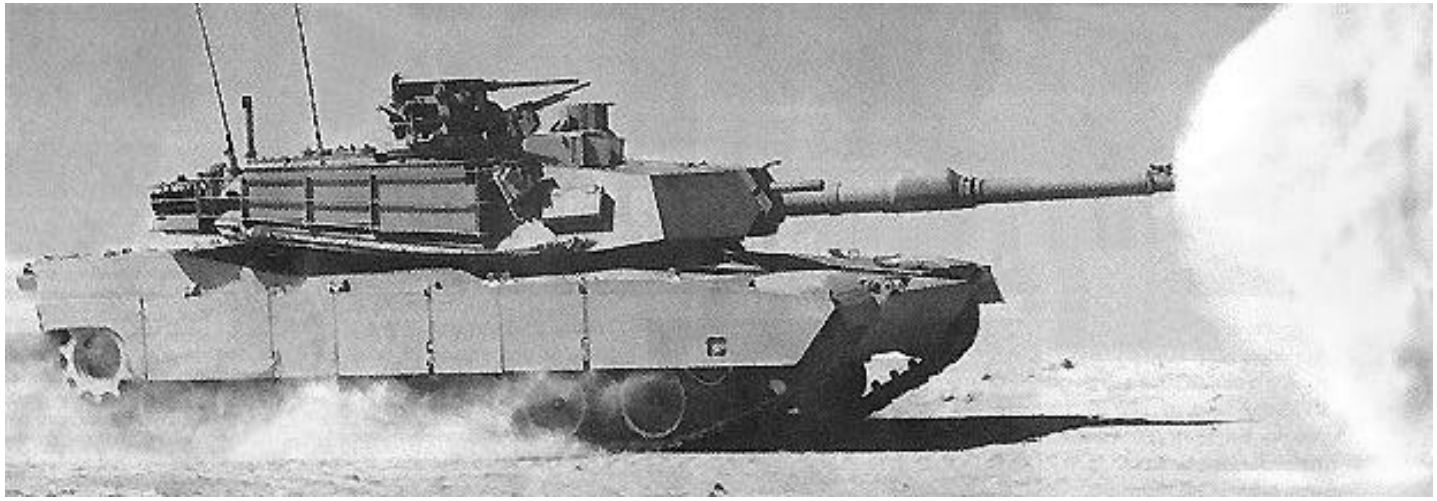
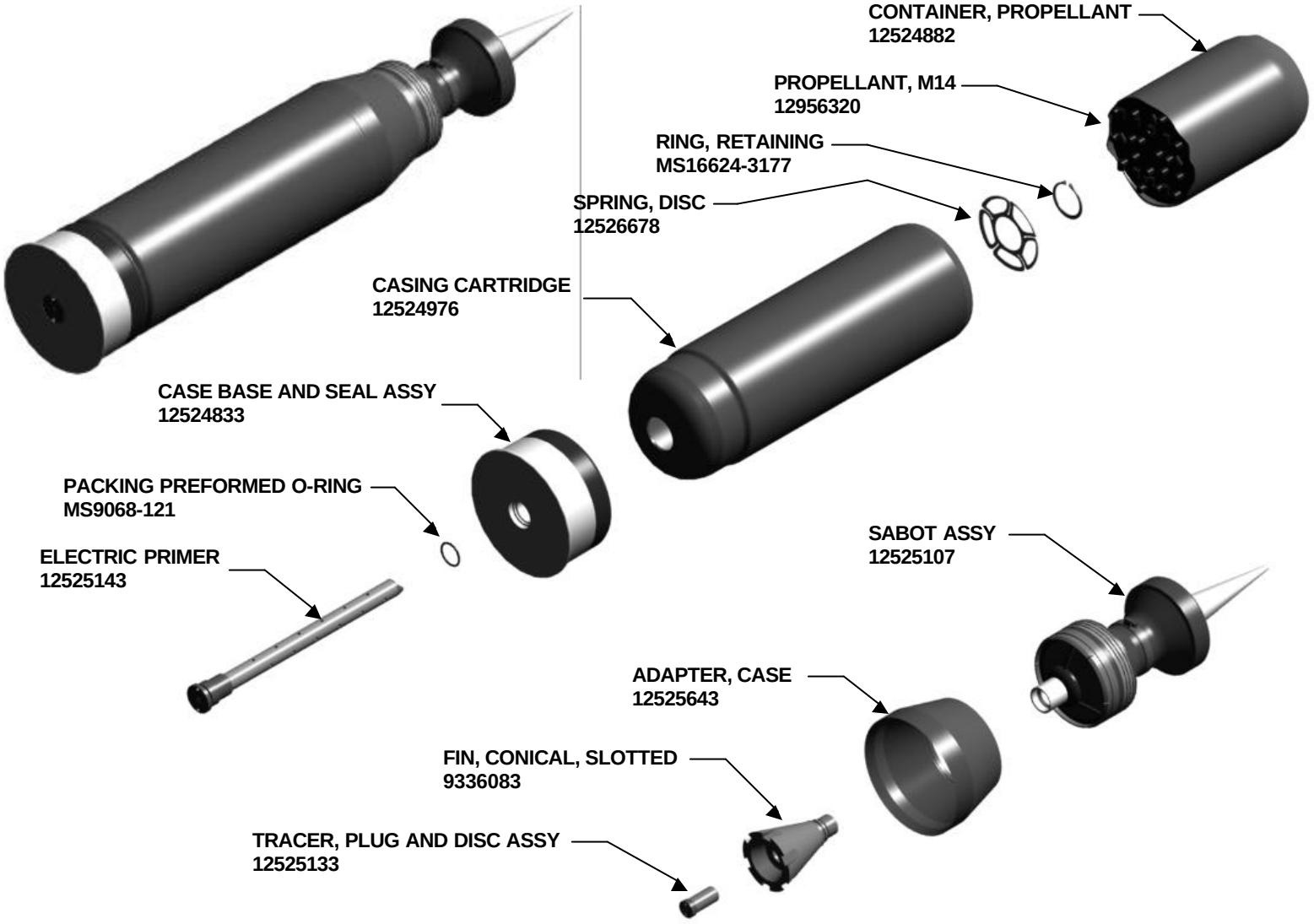
M865 120 mm Tank Cartridge

- M865 is the 120 mm kinetic energy target practice cartridge for the M1A1 Abrams main battle tank with the M256 gun.



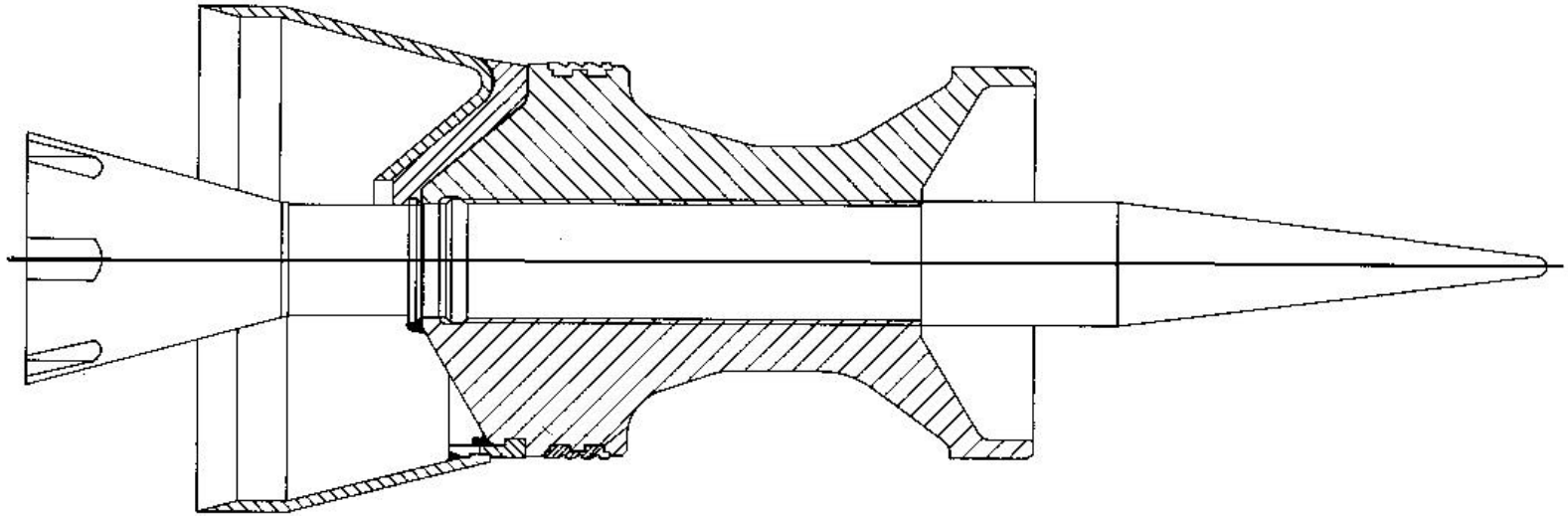
M865 CARTRIDGE, C785

M865 CARTRIDGE



Background

- In 1998-99 a major redesign of the M865 Cartridge aft seal and projectile to cartridge case attachment was implemented.



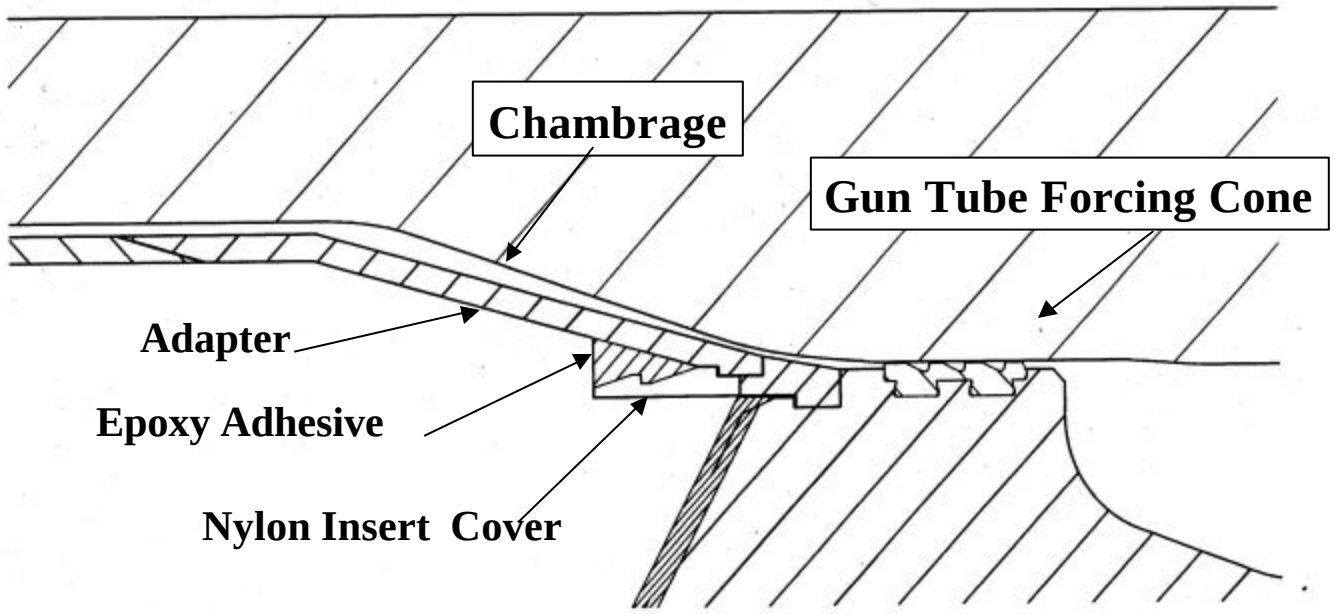
Background

- Shortly after release of these new rounds:

- Field reports of projectile separation.
- Lots suspended and production interrupted.
- Design changed to strengthen joint.

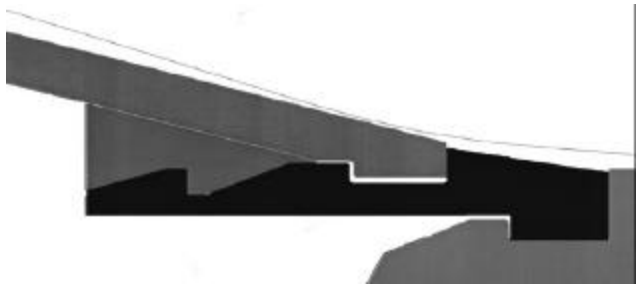
M865 Current Design

- In early 2000, a modification was introduced to provide a more durable projectile to cartridge case attachment.



Statement of Problem

- Field experience of mod. indicates:
- New issue of 2% chambering failures due to small pieces of adapter/epoxy left in the gun chamber by the previously fired round.



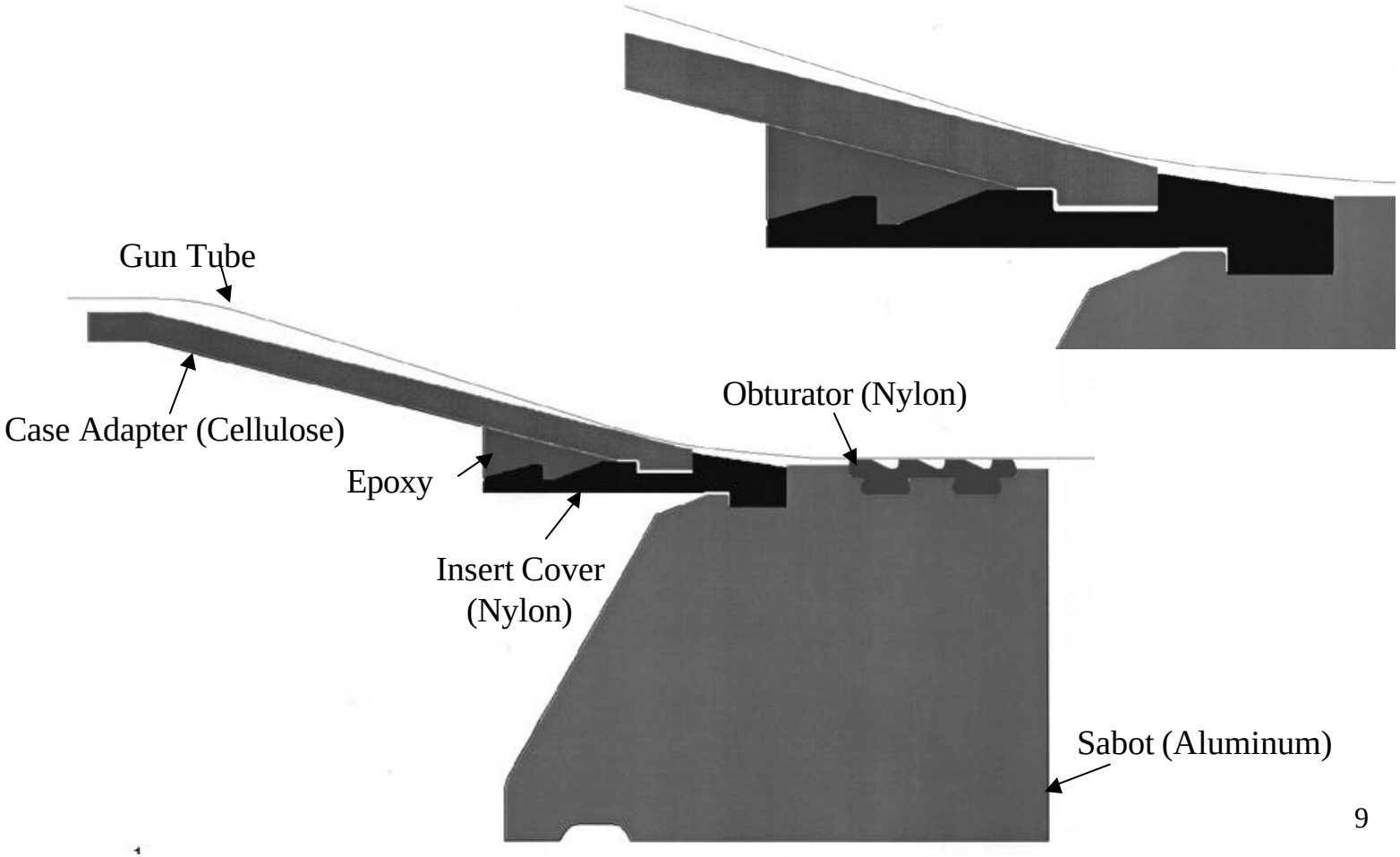
- Residue is more prevalent in worn gun tubes.

Approach - Computer Modeling

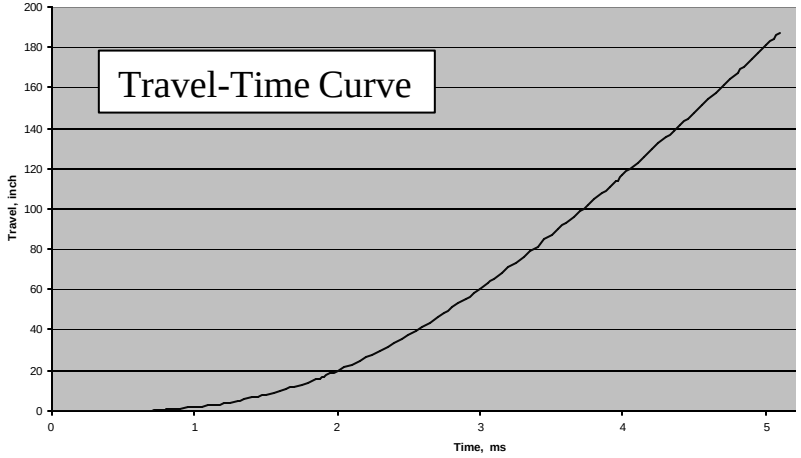
- To help solve the M865 residue issue it is beneficial to understand the dynamic loads that the cartridge experiences during the early stages of the ballistic cycle in the M256 gun tube.

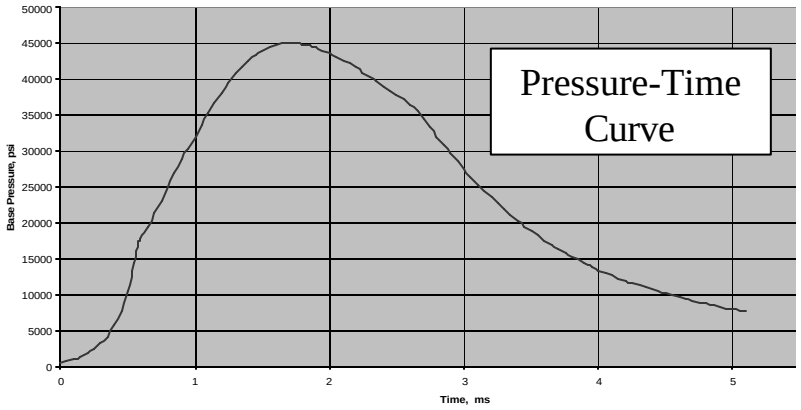
- ATK ‘s Dr. Dipak Kamdar developed a computer model of the pressures the M865 cartridge sees in the M256 gun tube during firing.

Finite Element Model (FEM)



FEM – Ballistic Data



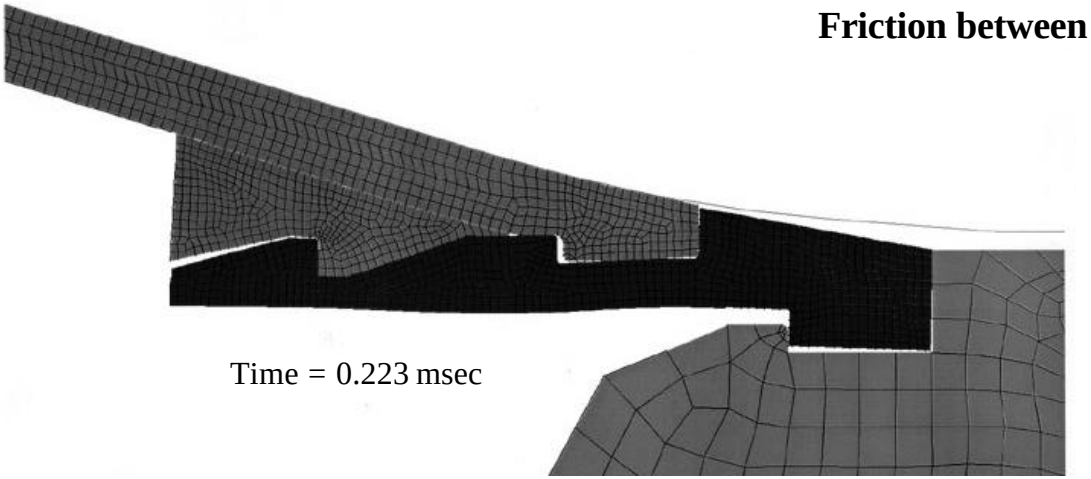


TIME (MS)	TRAV inch	VEL (M/S)	ACC (G)	BASE PRESS psi
0.00	0.000	0.00	541	477
0.05	0.000	0.33	804	661
0.10	0.000	0.80	1157	909
0.15	0.000	1.48	1629	1239
0.20	0.000	2.43	2259	1681
0.25	0.000	3.73	3102	2272
0.30	0.039	5.52	4233	3066
0.35	0.039	7.95	5760	4140
0.40	0.039	11.25	7839	5601
0.45	0.079	15.76	10696	7610
0.50	0.118	21.92	14667	10401
0.55	0.157	30.40	20246	14323
0.58	0.197	36.18	24117	17044
0.60	0.236	41.83	25149	17791
0.65	0.315	54.66	27197	19473
0.70	0.472	68.50	29252	21231
0.75	0.591	83.34	31295	23055

Current Production Design

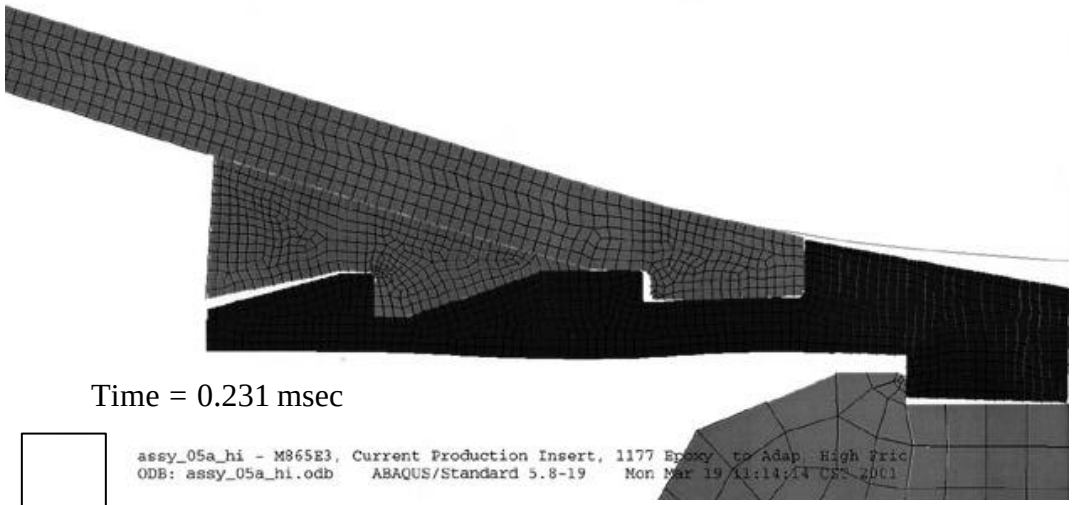
Deflected Geometry Under Applied Load

Friction between Case Adapter and Gun Tube



Time = 0.223 msec

Low Friction

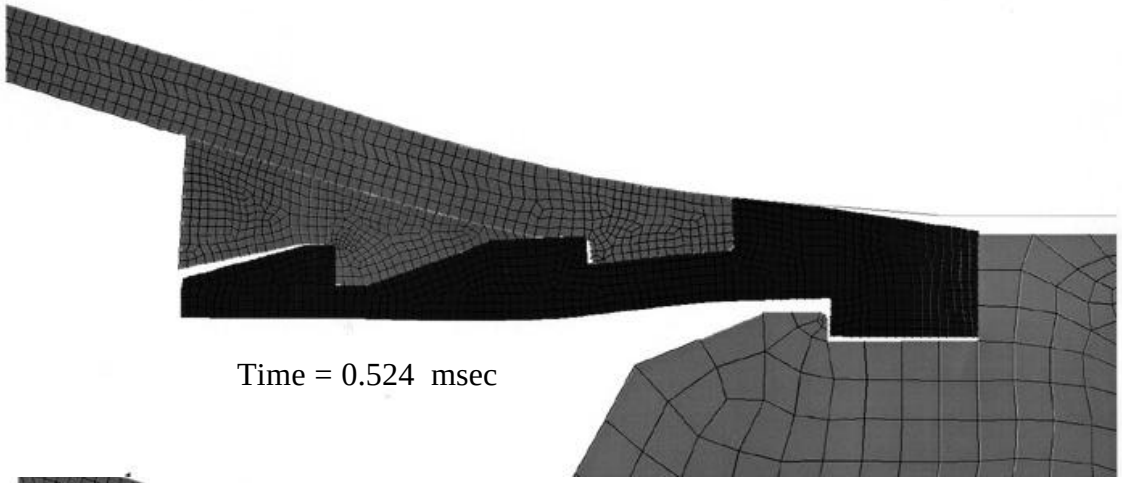


Time = 0.231 msec

High Friction

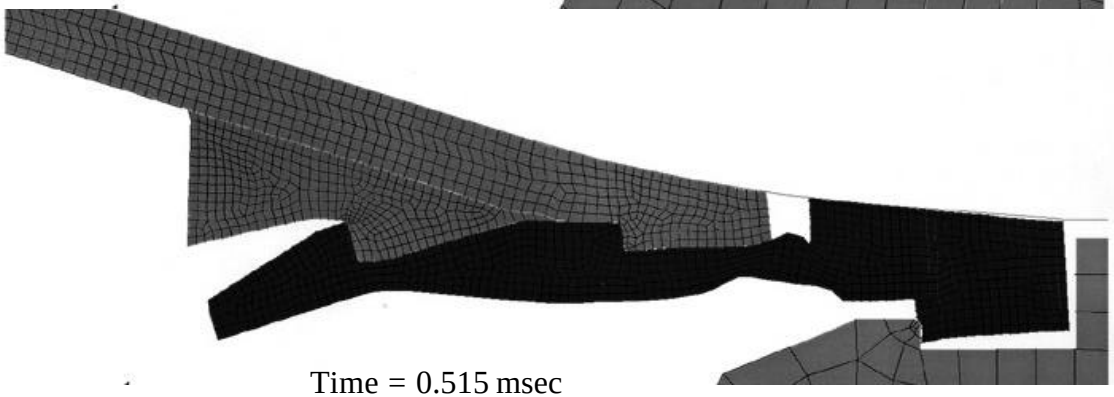
Current Production Design

Deflected Geometry Under Applied Load



Time = 0.524 msec

Low Friction

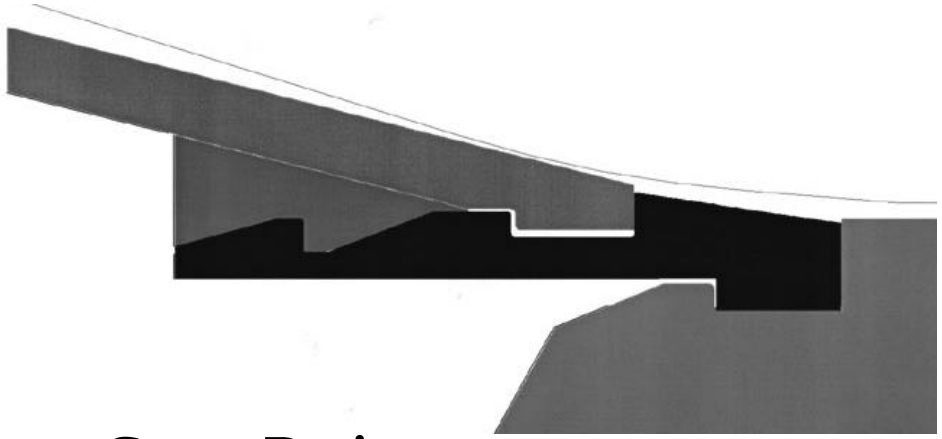


Time = 0.515 msec

High Friction

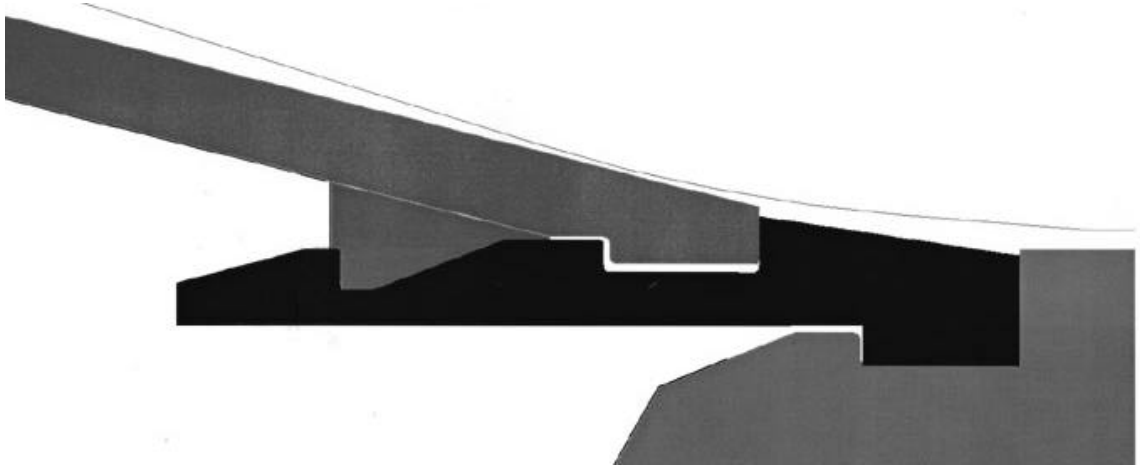
Insert Cover Fails – Does not Pull Adapter in the Gun Tube with High Friction

Modification to Baseline Design Computer Simulations

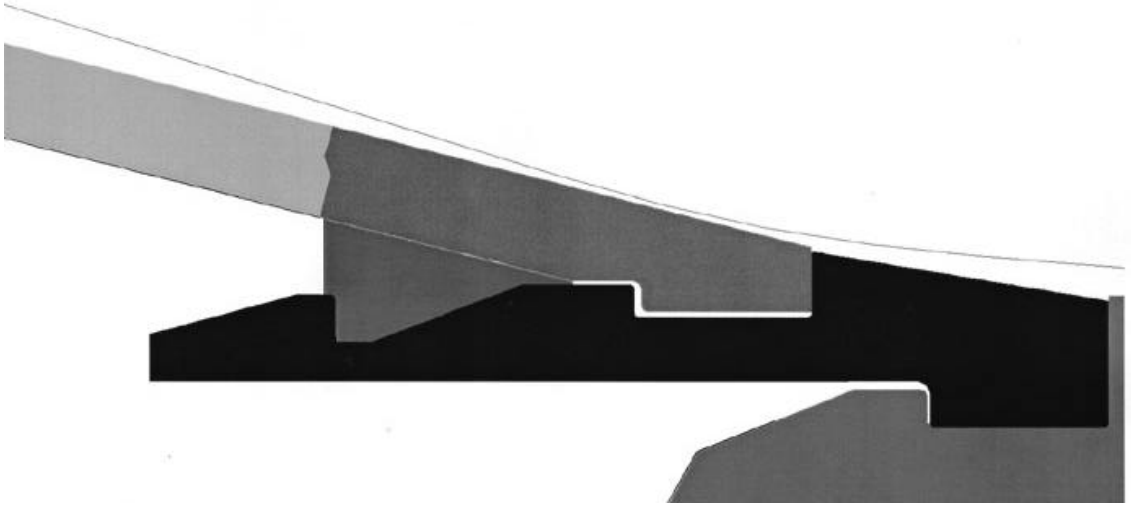


- ❑ Revised Insert Cover Design
- ❑ New Epoxy that Adheres to Both Insert Cover and Case Adapter
- ❑ Epoxy Adhesion to Insert Cover Only
- ☑ ❑ Half Epoxy
- ❑ Various Combinations of Insert Cover, Type and Amount of Epoxy

Modification to Baseline Design
Half Epoxy



Current Production Insert Cover & Production Epoxy

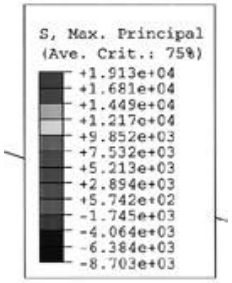


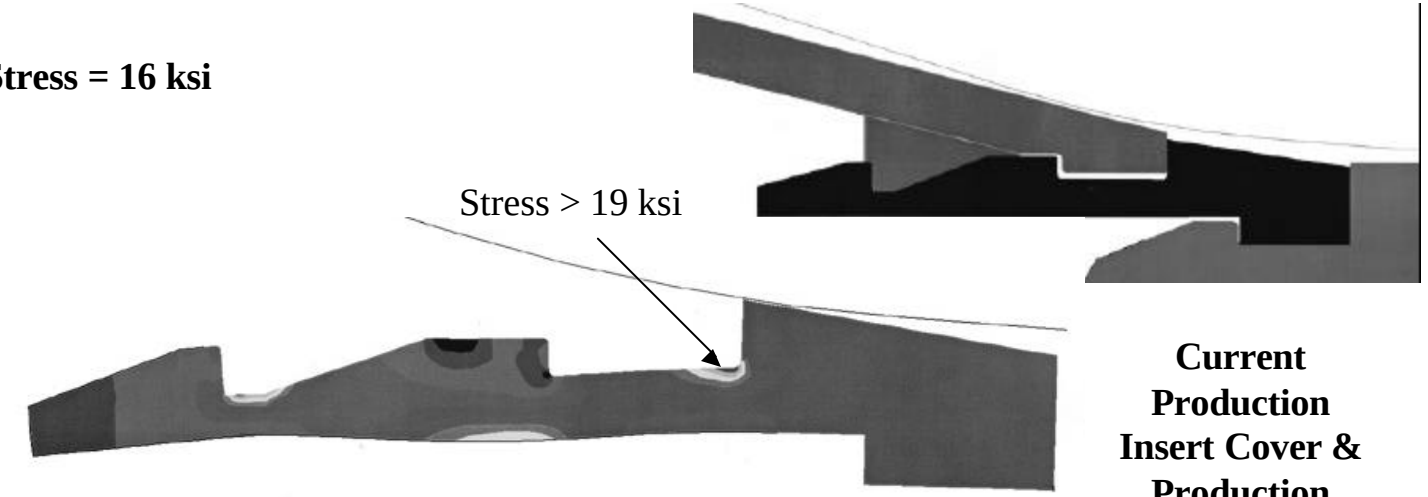
Next Generation Insert Cover & Production Epoxy

Modified Design – Half Epoxy

Max. Principal Stress in Insert Cover

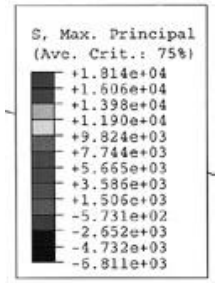
Allowable Stress = 16 ksi

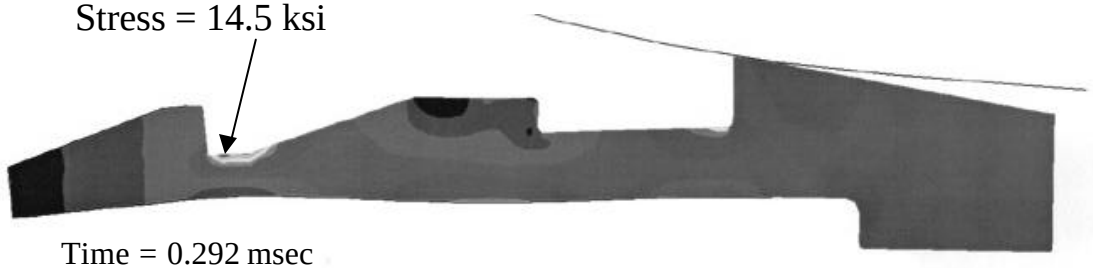




Time = 0.291 msec

Current Production Insert Cover & Production Epoxy





Time = 0.292 msec

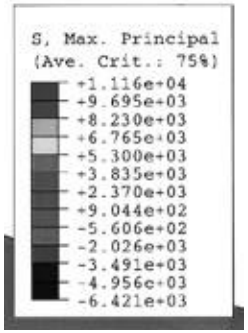
Next Generation Insert Cover & Production Epoxy

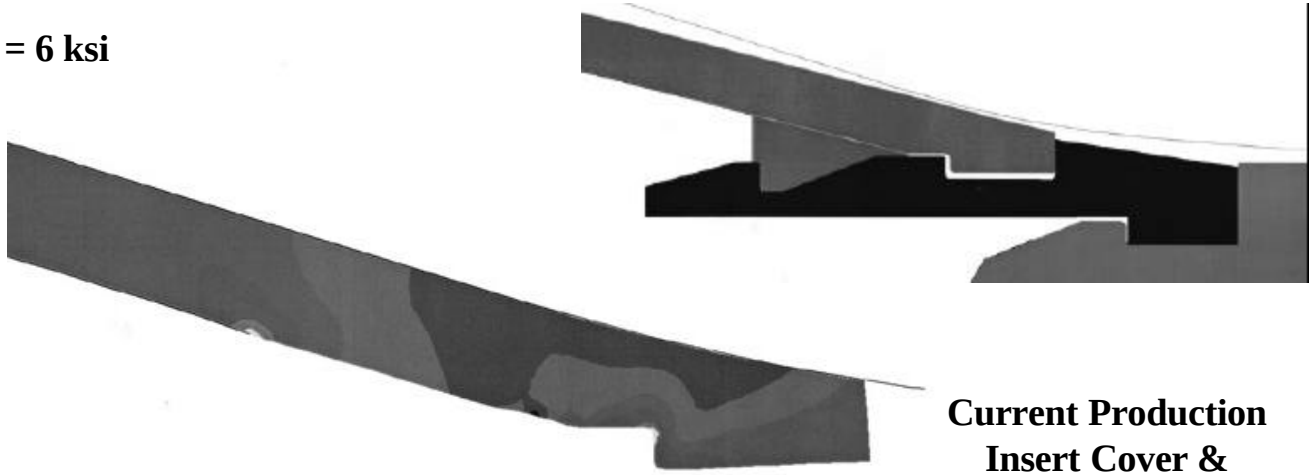
Next Generation Insert Cover Stays Intact While Current Insert Cover Fails

Modified Design – Half Epoxy

Max. Principal Stress in Case Adapter

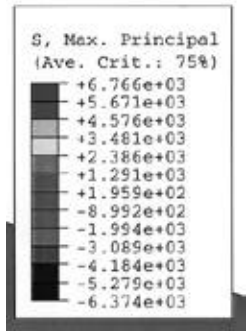
Allowable Stress = 6 ksi





Time = 0.355 msec

Current Production Insert Cover & Production Epoxy



Stress = 5.9 ksi

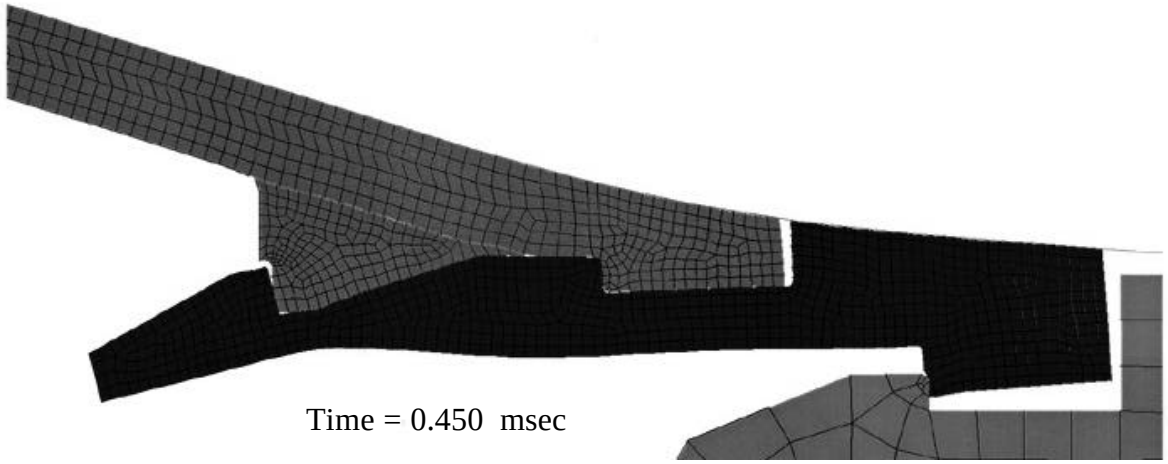
Time = 0.350 msec

Next Generation Insert Cover & Production Epoxy

Case Adapter Aft of Epoxy Removed

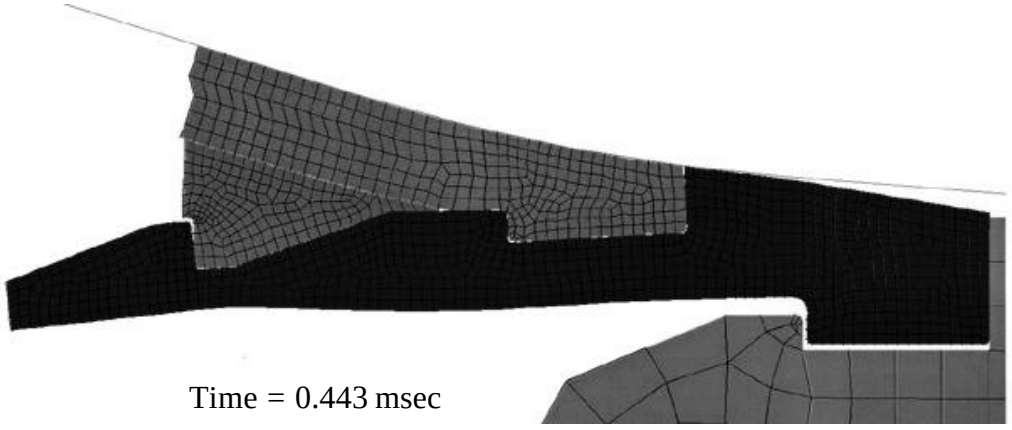
Modified Design – Half Epoxy

Deflected Geometry Under Applied Load



Time = 0.450 msec

Current Production Insert Cover & Production Epoxy

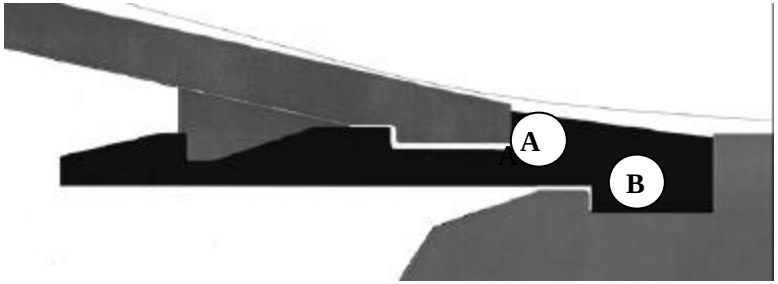


Time = 0.443 msec

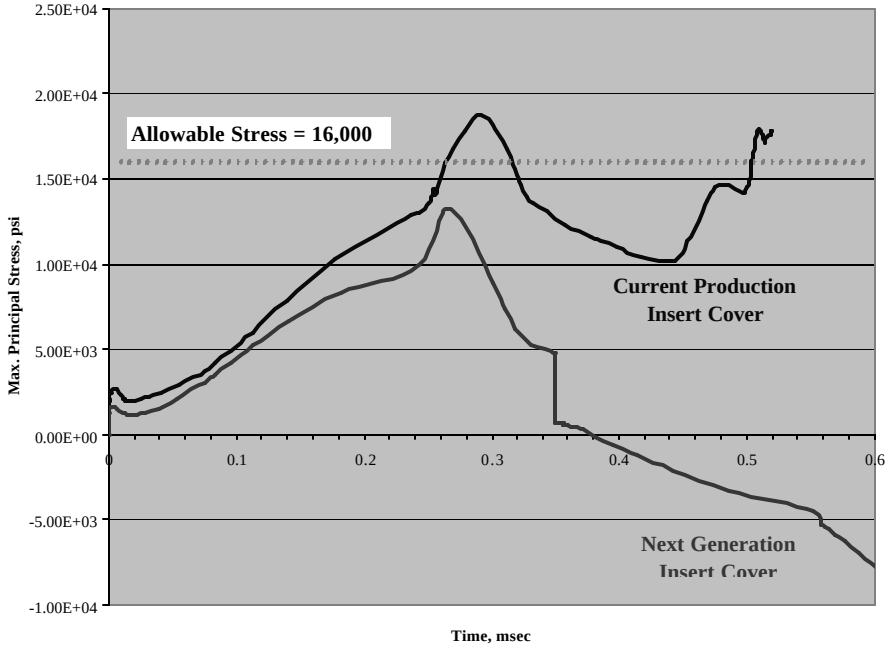
Next Generation Insert Cover & Production Epoxy

Comparison of Stress in Insert Cover

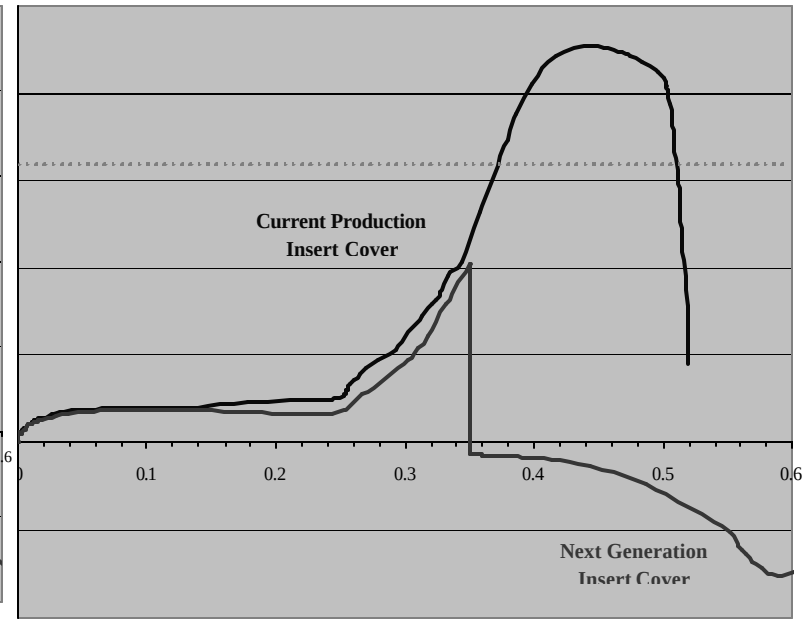
Time-History Plot of Stress in Insert Cover



Location A



Location B



Summary

- Computer Simulations Validates the Field Residue Phenomenon
- Computer Simulations Provides Understanding of Failure Mechanism
- Computer Modeling Provides Basis for Design Modifications